Review Article

The influence of the use of rotary photo tables for the presentation of goods on the volume of their sale in online stores

ABSTRACT

Aims: The purpose of this article was to confirm the dependence between the volume of sales of goods by online stores and the use of rotary photo tables for the presentation of goods, using mathematical methods and models. The use of correlation-regression analysis to assess economic processes and trends, as well as the development of a model of dependence between the volume of sales of goods by an online store and the use of rotary photo tables for the presentation of goods.
Study design: In order to determine the relationship between the volume of sales of goods in the online store and the use of rotary photo tables for the presentation of goods, an economic and mathematical modeling was carried out in the work based on the database of online stores «Yin.gold», «Nihaoejwelry Wholesale Store», «W.P. Jewellery».
Methodology: The following methods were used in this research: analysis, synthesis, induction, deduction, comparison, grouping, methods of mathematical modeling and mathematical statistics. The use of these methods is aimed at achieving the tasks set in the research. The information base of the research consists of the works of recognized specialists, as well as data from the online stores «Yin.gold», «Nihaoejwelry Wholesale Store», «W.P. Jewellery».
Results: On the basis of mathematical methods (correlation-regression analysis), it was confirmed an actual dependence between the volume of sales of goods by online stores and the number of goods that are presented with the help of photos and videos made with the use of rotary tables for photography. The economic effect of using rotary photo tables for object photography for the investigated online stores is quantified.
Conclusion: The conducted research confirmed the high importance of using rotary photo tables for the presentation of goods in the online store. The economic interpretation of the parameters of each of the built models shows that the increase in the number of products presented on the website of the online store with the use of rotary tables for photography leads to an increase in the volume of sales.

Keywords: rotary tables, product presentation, online store, correlation, regression, dependence, volume of sales.

1. INTRODUCTION

Product photography is gaining more and more popularity in modern conditions. Many stores go online and need high-quality photos that will help show the product from all sides and in the most attractive light. For this purpose, it is advisable to use rotary photo tables for product ϕphotographs [6]. Under such conditions, the question of determining the dependence between the volume of sales of goods in the online store and the use of rotary photo tables for the presentation of goods becomes particularly relevant. It is expedient to carry out such a research with the help of a mathematical apparatus, which is one of the most effective tools for the research of complex economic problems and allows modeling the main properties of real processes and phenomena [13].

The purpose of this research was to confirm the fact of a dependenceship between the volume of sales of goods by an online store and the use of rotary photo tables for the presentation of goods, which was found in a previous research. To achieve this goal, mathematical methods and models were used, namely, the correlation-regression method was used to assess economic processes and trends. Techniques and methods of mathematical modeling also made it possible to develop models of dependence between the volume of sales of goods by online stores and the use of rotary photo tables for their presentation.

The tasks of mathematical modeling in the economic sphere of activity are traditionally the main, and in our time, extremely important. The use of mathematial methods at various fields of knowledge, the introduction of information technologies, the complication of production and technological processes, the need to analyze large volumes of information for successful decision-making and forecasting, management decision-making lead to the need to build mathematical models of varying complexity. Since, mathematical models allow to describe essential connections between economic processes and phenomena, to forecast economic indicators, to develop management strategies of economic objects [3]. The use of mathematical methods significantly expands capabilities of modeling process, allows to formulate a new tasks, and improves the quality of management decisions. A mathematical model is the highest degree of formalization of any process (phenomenon), which allows the most simple and complete analysis of the dependence between the parameters characterizing this process (phenomenon).

The conducted a research of literary sources showed that there are no such by other authors aimed at determining the influence between the volume of sales of goods in the online store and the use of rotary photo tables for the presentation of goods.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

The following methods were used in this research: analysis, synthesis, induction, deduction, comparison, grouping, methods of mathematical modeling and mathematical statistics. The use of these methods is aimed at achieving the tasks set in the research. The information base of the research consists of the works of recognized specialists, as well as data from the «Yin.gold», «Nihaoejwelry Wholesale Store», «W.P. Jewellery» online stores. The data used in this study are taken exclusively from open sources.

The task of correlation-regression analysis is the construction and analysis of an economic-mathematical model of the regression equation (correlation equation), which reflects the dependence of the resulting characteristic on several factor characteristics and gives an estimate of the degree of dependece density [9].

Correlation relations are established on average for a large set of data from the information base, which has sufficiently typical and reliable statistical characteristics, as well as qualitative homogeneity (closeness of the conditions for the formation of effective and factor characteristics) and quantitative homogeneity (the absence of a unit of observation, which, according to numerical characteristics, significantly different from the main body of data). These features require the solution of two problems: finding the form of the functional dependence and determining the degree of approximation of the correlation dependence behind it [10].

One of the simplest and most common models is a linear regression, but it usually cannot provide the necessary forecasting accuracy [18]. Multifactor models (multiple correlation) are used to increase the accuracy of the forecast and reduce the variability of the indicator. When choosing independent variables (factors) in such models, it is necessary to take the presence of a dependence with the dependent variable (indicator) and the absence of a close connection with any other independent variable into account, that is, mutual correlation [5]. Factors should reflect different aspects of the researched process. To analyze the density of the dependence in a multi-component correlation-regression model, a matrix of paired correlation coefficients is created, which measures the density of the linear dependence of each factor with the resulting feature and with each of the remaining features-factors (correlation matrix). According to the form of the dependence, direct and inverse, linear and non-linear, single and multi-component correlations are distinguished. Direct and inverse relationships are distinguished depending on the direction of change of the resulting characteristic when the factor characteristic changes. If the directions match - direct dependence, if not – inverse. Depending on the nature of the change in the indicator Y when the factor X changes, linear and non-linear relationships are distinguished.

The set of information input data must be checked for the presence of linear dependence between all or several factor characteristics (multicollinearity). There are objective dependence between individual factors in economic processes. Multicollinearity, as a rule, "presents" itself in a stochastic (hidden) form. Its presence leads to a serious decrease in the accuracy of estimates of the regression parameters, distortion of the estimate of the variance of the residuals, the variance of the regression coefficients [12].

Regression coefficients become unreliable, they cannot be interpreted as a measure of the influence of the relevant factor on the independent variable. The estimates become very sensitive to the sample data, that is, a small increase in the sample size can cause significant changes in the values of the estimates.

Therefore, an appropriate check must be performed, because the resulting regression will be characterized by high variability and some redundancy (calculated values are higher than expected). When checking for multicollinearity, first, the statistical values of factor characteristics Xi are replaced by standardized (normalized) data. A correlation matrix is then constructed, which consists of correlation coefficients calculated for each possible pair of variables. The analysis of the obtained dependencies makes it possible to assess the degree and direction of the dependence between the factors. Next, the determinant of the correlation matrix is calculated, which indicates a possible correlation between the factors (if the value is close to zero) [5].

General multicollinearity in the array is detected by the Pearson test (x2). Then, partial correlation coefficients are determined, which characterize the closeness of the dependence between two variables, provided that the third one does not affect this relationship. Further, with the help of t-statistics, pairs of factors between which there is multicollinearity are revealed.

Once stochastic multicollinearity is established, it should be eliminated whenever possible. One of these methods is the method of extracting variables (factors). Its essence is to remove (should be consistent with the purpose of the research and economic feasibility) one or more highly correlated explanatory variables from the regression [14]. The new model is then re-estimated. For verification, several possible models are built and the value of the coefficient of determination R2 is calculated. It measures the share of the variation of the indicator, which is explained by the connections between the independent variable and the factors, and the calculated value of the Fisher criterion Fp.

The closer the value of R2 to 1, the better the statistical data correspond to the constructed regression function [15]. The value should be several times higher than the tabular value, then the regression will not only be significant, but also have practical value for forecasting.

The general equation of multiple linear regression has the form [11]:

$$y = a_0 + a_1 x_1 + a_2 x_2 + \ldots + a_n x_n \quad (1)$$

where y is the resulting variable:

$x_1, x_2 \ldots x_n$ – independent variables;

$a_0, a_1 \ldots a_n$ – parameters.

After removing one variable, a two-factor model is constructed. The coefficients of the regression equation are calculated using matrix operations [1].

The procedure for obtaining the system of normal equations for pairwise correlation is as follows. To obtain the first equation of the system, it is necessary to multiply all terms of the original correlation equation by the coefficient for the first unknown (a) and add the obtained products [2]. Then, to obtain the second equation, it is necessary to multiply all terms of the original equation by the coefficient for the second unknown (b) and also add all the products. The technique of obtaining a system of normal equations remains similar to the construction of a system of equations with a larger number of variables. So, for a pair of linear connections, the system of normal equations has the form:

$$\{\sum y = an + b\sum x,\ \sum yx = a\sum x + b\sum x^2 \quad (2)$$

The correlation equation was used to calculate the theoretical regression line and the expected values of the dependent variable at the corresponding values of the factor (factors).

After finding the estimates of the a0 , a1, and a2 regression parameters, the new model is tested for multicollinearity. If the result is positive, the adequacy of the model (regression equation) is checked by Fisher's test and the significance of regression parameters (individual factors) by Student's test.

When studying the correlation relationship, along with solving the regression equation, it became necessary to determine the degree of closeness of the connections between the variables, using a special relative indicator called the correlation coefficient.

3. RESULTS AND DISCUSSION

To confirm the close relationship established in the past research between the volume of sales of goods by an online store and the number of goods that are presented with the help of photos and videos made with the use of rotary tables for photography. We compare the results of the correlational regression analysis obtained in the previous research with the data of two other similar online stores that sell jewelry and use rotary tables for object photography to present products on the website. To build a correlation-regression model, we chose the factors presented in Fig. 1.

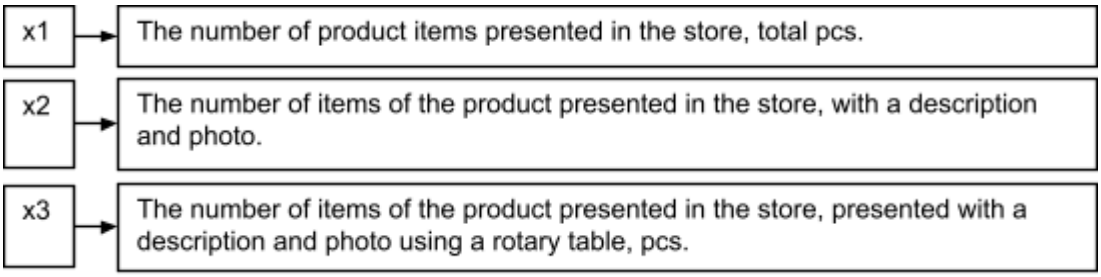

Fig. 1. Factors of the correlation-regression model

Source: developed by the author

Table 1 presents the data for the correlation-regression analysis of selected jewelry online stores.

Table 1. Data for conducting a correlation-regression analysis of the influence of the relationship between the volume of sales of goods and the use of rotary photo tables for their presentation on the Internet

Year	The volume of sales of goods, dollars . USA	The number of items of the product presented in the store		
		Total, pcs.	presented with description and photo, pcs.	presented with a description and photo using a rotary table, pcs.
		Yin.gold Store		
2015	131805	3980	3215	2890

2016	90615	2950	2770	2060
2017	93270	3100	2880	2236
2018	112154	4080	3200	2560
2019	130832	4400	3125	2670
2020	153781	4170	2990	2760
2021	155337	3900	3220	3098
Nihaoejwelry Wholesale Store				
2015	254383.7	4557	3697	3208
2016	173074.7	4752	3186	2287
2017	179078.4	4064	3312	2482
2018	216457.2	4125	4256	2842
2019	245964.2	4884	3688	2964
2020	292183.9	5421	3917	2971
2021	295140.3	4329	3703	3439
WP Jewellery Store				
2015	427364.5	3509	3143	5389
2016	117690.8	3659	2708	2149
2017	121773.3	3129	1656	2333
2018	194811.5	3176	3618	2557
2019	167255.6	3761	3134	2786
2020	198685.1	4174	2742	3268
2021	200695.4	3333	3148	4470

Source: constructed by the author

We will analyze the relationship between the volume of sales of goods and the number of goods presented in the online store with only a description, with a description and a photo, as well as with a photo taken using a rotary photo table from 2015 to 2021 using the correlation coefficient. This coefficient characterizes the linear correlation (that is, the connection that is given by a certain value and direction) of two or more variables.

To calculate the correlation, we use the Pearson formula:

$$r_{xy} = \left(\frac{1}{n-1}\right) \sum \left(\frac{x-\mu_x}{\sigma_x}\right) * \left(\frac{y-\mu_y}{\sigma_y}\right) \quad (3)$$

where:

r_{xy} - correlation coefficient;

n– number of periods;

x_n, y_n – values of variables x and y;

μ_x, μ_y – average arithmetic value of x and y;

σ_x, σ_y are standard deviations x and y.

The value of the correlation coefficient is between -1 and +1, that is, the correlation can be both positive and negative. When the value of the correlation coefficient is -1, there is a perfect negative correlation; when the value of the correlation coefficient is +1, there is a

perfect positive correlation. In other cases, there is a positive correlation, a negative correlation, or no correlation between the two variables [12].

To determine the correlation between the selected indicators in the period from 2015 to 2021, we will calculate the value of the correlation indicators. The level of correlation of the factors selected for building the model with the resulting indicator is presented in Table 2.

Table 2. Correlation level of the factors selected for the construction of the correlation-regression analysis model model with the volume of sales of goods by online stores

		Y	X1	X2	X3
Yin.gold Store					
Volume of sales of goods	Y	1			
The number of items of the product presented in the store	X_1	0.757583	1		
The number of items of the product presented in the store with a description and photo	X_2	0.63594	0.784898	1	
The number of product positions presented in the store with photos using rotary photo tables	X_3	0.920779	0.754677	0.854582	1
Nihaoejwelry Wholesale Store					
Volume of sales of goods	Y	1			
The number of items of the product presented in the store	X_1	0.440783	1		
The number of items of the product presented in the store with a description and photo	X_2	0.526104	0.036891	1	
The number of product positions presented in the store with photos using rotary photo tables	X_3	0.89727	0.065626	0.537423	1
WP Jewellery Store					
Volume of sales of goods	Y	1			
The number of items of the product presented in the store	X_1	0.039697	1		
The number of items of the product presented in the store with a description and photo	X_2	0.406947	0.087105	1	

The number of product positions presented in the store with photos using rotary photo tables	X_3	0.877282	0.057825	0.345758	1

Source: constructed by the author

The value of the correlation coefficient is always in the range from -1 to +1, the closer the value is to 0, the lower the level of dependence, and accordingly, the closer the value is to 1, the higher the level of dependence of the indicators between other [15]. Need to note that a correlation coefficient with a positive value means a direct dependence, and with a negative value means an inverse dependence [16]. A high degree of dependence is considered to be the value of the correlation coefficient (modulo) higher than 0.85.

Based on this, it can be argued that the number of products presented using photos and videos made using rotary tables for photography has a significant impact on the volume of sales in the online store (table 2), since the correlation coefficient for this factor is higher than 0.85. So, to build a correlation-regression model, it is advisable to use the indicator of the number of items of the product presented in the store with photos using rotary photo tables.

The significance check of the regression model is carried out using Fisher's F-Criterion, the calculated value of which is defined as the ratio of the variance of the original series of observations of the studied indicator and the unbiased estimate of the variance of the residual sequence for this model [20].

If the estimated value with k1=(m) and k2=(nm-1) (m is the number of factors in the model) degrees of freedom is higher than the tabular value at the specified level of significance, then the model is considered significant. To assess the statistical significance of the paired linear regression, the null hypothesis is put forward that the equation as a whole is statistically insignificant: R2=0 at the α level of significance [18].

Next, the actual value of the F-Criterion is determined by the formula:

$$F = \frac{R^2}{1-R^2} * \frac{n-m-1}{m} \quad (4)$$

where:

m=1 for paired regression.

The tabular value (Ftab.) is determined based on the Fisher distribution table for a given level of significance, taking into account that the number of degrees of freedom for the total sum of squares (larger variance) is 1, and the number of degrees of freedom of the residual sum of squares (smaller variance) in linear regression is n-2.

Ftab. is the maximum possible value of the criterion under the influence of random factors with the given degrees of freedom and significance level α. The significance level α represents the probability of rejecting the correct hypothesis, given that it is true. Usually α is taken equal to 0.05.

If the actual value of the F-Criterion is lower than the table value, then there is no reason to reject the null hypothesis [16]. And if not, then the null hypothesis is rejected and the

alternative hypothesis about the statistical significance of the equation as a whole is accepted with probability (1-α).

In our case, for all the selected models, the calculated value of the F-Criterion is higher than the table values.

Since the actual value of F>Ftab., the coefficient of determination is statistically significant (the regression equation estimate found is statistically reliable), and the proposed models are significant.

To confirm the significance of the correlation coefficient of the constructed models, we use the Student's test according to the next formula:

$$t = \frac{|r|(n-2)^{\frac{1}{2}}}{\left(1-r^2\right)^{\frac{1}{2}}} (5)$$

The calculated value of Student's test for all selected models is higher than the tabulated value. Since the actual values of the Student's coefficient are higher than those in the table, the linear correlation coefficients are significant, and the relationship between the volume of sales of goods in each online store and the number of goods presented with the help of photos and videos made with the use of rotary tables for photography is real.

Based on the data in Table 1, using formula 1, systems of equations were formed for each of the studied models. Solving which, we get the following regression coefficients:

for the «Yin.gold» store b = 67.0488, a = -51065.01;

for the «Nihaoejwelry Wholesale Store» b = 111.6810, a = -85535.06;

for the «W.P. Jewellery» store b = 75.7887, a = -44479.35.

Substituting the obtained values into the equation of linear dependence, we obtain the following regression equations, which have the form:

$$y = 67,0488x_1 - 51065,01 \text{ "Yin.gold"}$$

$$y = 111,6810 - 85535,06 \text{ "Nihaoejwelry Wholesale Shop"}$$

$$y = 75,7887x_1 - 44479,35 \text{ "W.P. Jewellery" (6)}$$

where y is the volume of sales of goods;

x_1 – the number of products that are presented with the help of photos and videos made using rotary tables for photography.

Therefore, the calculations allow us to state that for each of the investigated online stores, the statement that the increase in the volume of goods presented on the website with the help of rotary tables for photo shooting will lead to an increase in the volume of sales is true. So: for the «Yin.gold» store, an increase in the number of products presented with the help of photos and videos made with the use of rotary tables for photography by one hundred will lead to an increase in the volume of sales of goods by 6,704 US dollars;

for the «Nihaoejwelry Wholesale Store» an increase in the number of goods that are presented with the help of photos and videos made with the use of rotary tables for photography by one hundred will lead to an increase in the volume of sales of goods by 11,168 US dollars;
for the «W.P. Jewellery» store, an increase in the number of products presented with the help of photos and videos made with the use of rotary tables for photography by one hundred will lead to an increase in the volume of sales of goods by 7,578 US dollars.

4. Conclusion

There has been a steady trend towards a close dependence between the volume of sales of goods by online stores and the quality of the presentation of goods on the store's website in recent years. On the basis of mathematical methods application (correlation-regression analysis), it was proved that there is a relationship between the volume of sales of goods and the use of rotary photo tables for product photography for their presentation. The conducted research confirmed the results of the previous research and shows that the use of rotary photo tables for the presentation of goods in online stores is extremely important. In the course of the research, it was confirmed that there is a close relationship between the volume of sales of goods by online stores and the number of goods that are presented with the help of photos and videos made with the use of rotary tables for photography. Thus, the research of the data of three online stores that sell jewelry showed the presence of a close relationship between the volume of sales of goods and the use of rotary photo tables for their presentation in the store. This dependence is explained by the fact that the use of rotary tables for objective photo shooting allows you to present the product to a potential buyer better by demonstrating all its details and features. In the result of the research, the economic effect of increasing the use of rotary photo tables for product photo shooting by the investigated stores was determined. If the number of products that are presented using rotary tables for photography increases by one hundred units, the increase in the volume of sales for the «Yin.gold» store will amount to 6,704 US dollars, for the «Nihaoejwelry Wholesale Store» 11168 US dollars, and for the store «W.P. Jewellery» 7578 US dollars.

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